Nueces Delta Landform and Hydraulic Modifications

June 22, 2015

Texas Water Development Board

NaismithEngineering,Inc
ARCHITECTURE ■ ENGINEERING ■ ENVIRONMENTAL ■ SURVEYING

Strategic Purpose

To evaluate potential landform and hydraulic modifications intended to **moderate the high salinities** experienced in the Nueces Delta and Nueces Bay during periods of limited freshwater inflows, with the expected benefit of **improving marsh habitat**.

Project Objectives

To evaluate specific projects designed to **increase** the **area** and **duration of freshwater inundation of wetland areas within the Nueces Delta**.

Project Team

- Naismith Engineering, Inc.
  - Grant Jackson, P.E.
  - James Dodson
  - Dave Sullivan
  - Mary Kay Skoruppa
  - Kara Thompson
- TAMUCC Center for Coastal Studies
  - Brien Nicolau
  - Erin Hill
- UTMSI
  - Dr. Ken Dunton
- Dr. George Ward
- Dr. Ben Hodges

Naismith Engineering, Inc

COASTAL CENTER STUDIES TAMU-CC

THE UNIVERSITY OF TEXAS MARINE SCIENCE INSTITUTE

The Process

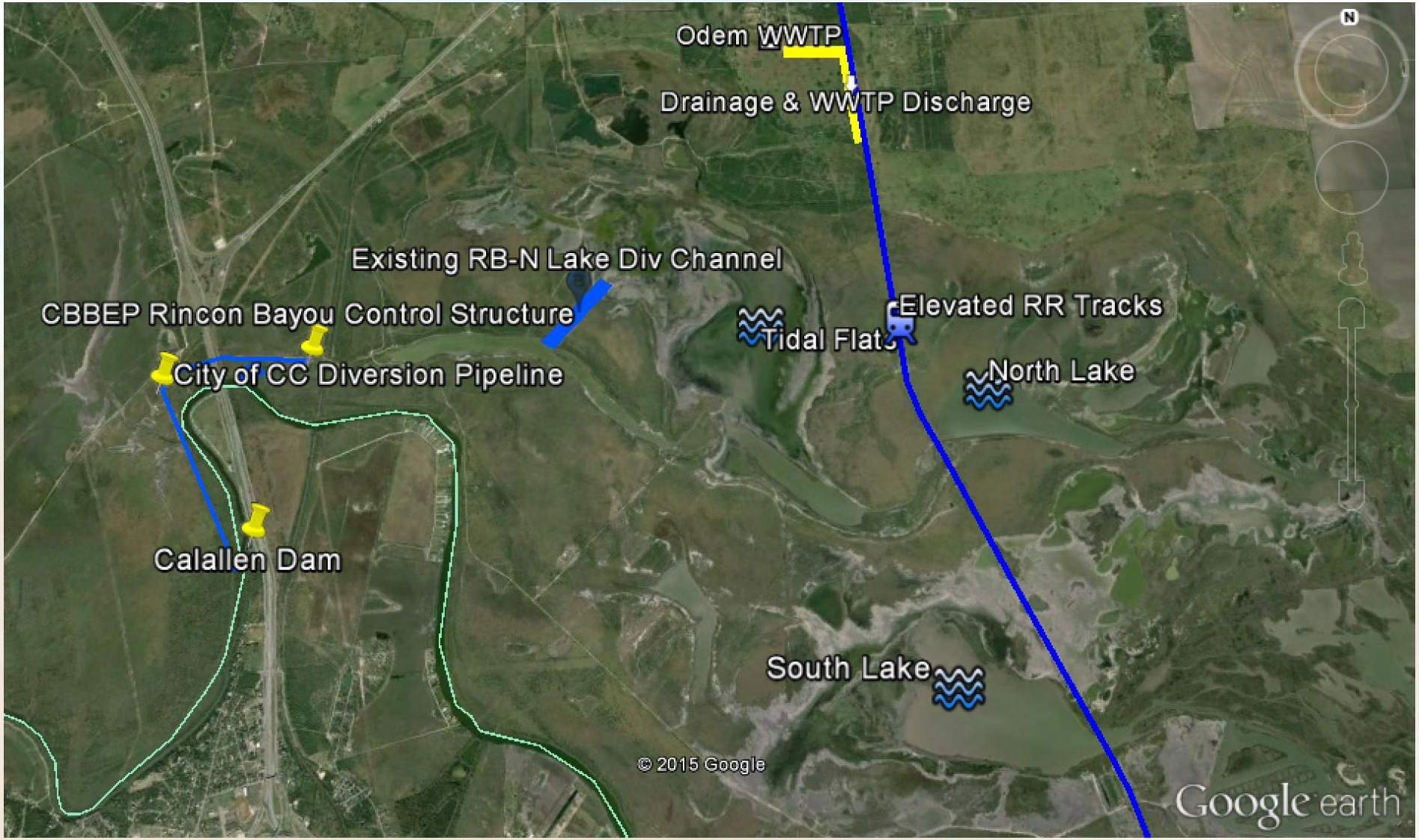
The Project Team drew on the collective experience and knowledge of over thirty years' work on the concept of diverting freshwater inflows from the Nueces River and making greater amount of freshwater available to the marsh systems within the Nueces Delta and areas within Upper Nueces Bay.

The development, analysis and final selection of the projects evaluated in this study involved an iterative process of professional judgement, modeling, evaluation of modeling results, solicitation of stakeholder input, refinement of options, additional modeling and synthesis of modeling results.

Study Area


Nueces Delta
Nueces River
Nueces Bay
77
5 Points Rd
69
Leopard St
56
37
407
1694
Violet Rd
2292
54
55
1074

Location of Existing Projects



Original Projects Evaluated

Project #	Project Title
1	*Upper Delta Nueces River to Rincon Bayou Diversion*
2	*Upper Rincon Bayou Diversion to high marsh/wetlands North of Rincon Bayou*
3	*East end of Upper Rincon Bayou control structure & diversion to South Lake area*
4	*Middle Rincon Bayou to South Lake Diversion*
5	*North Lake to South Lake system diversion*
6	*Lower Delta Nueces River Diversion*
7	*Diversion of Odem WWTP Discharge and Peters Swale Stormwater*
8	*Restoration of Allison WWTP Discharge to South Lake*
Others	*Nueces Delta Face/Nueces Bay Projects; Landform Modifications (as opposed to hydraulic modifications) to create/improve habitat (i.e., excavations)*

Projects Included in Final Modeling

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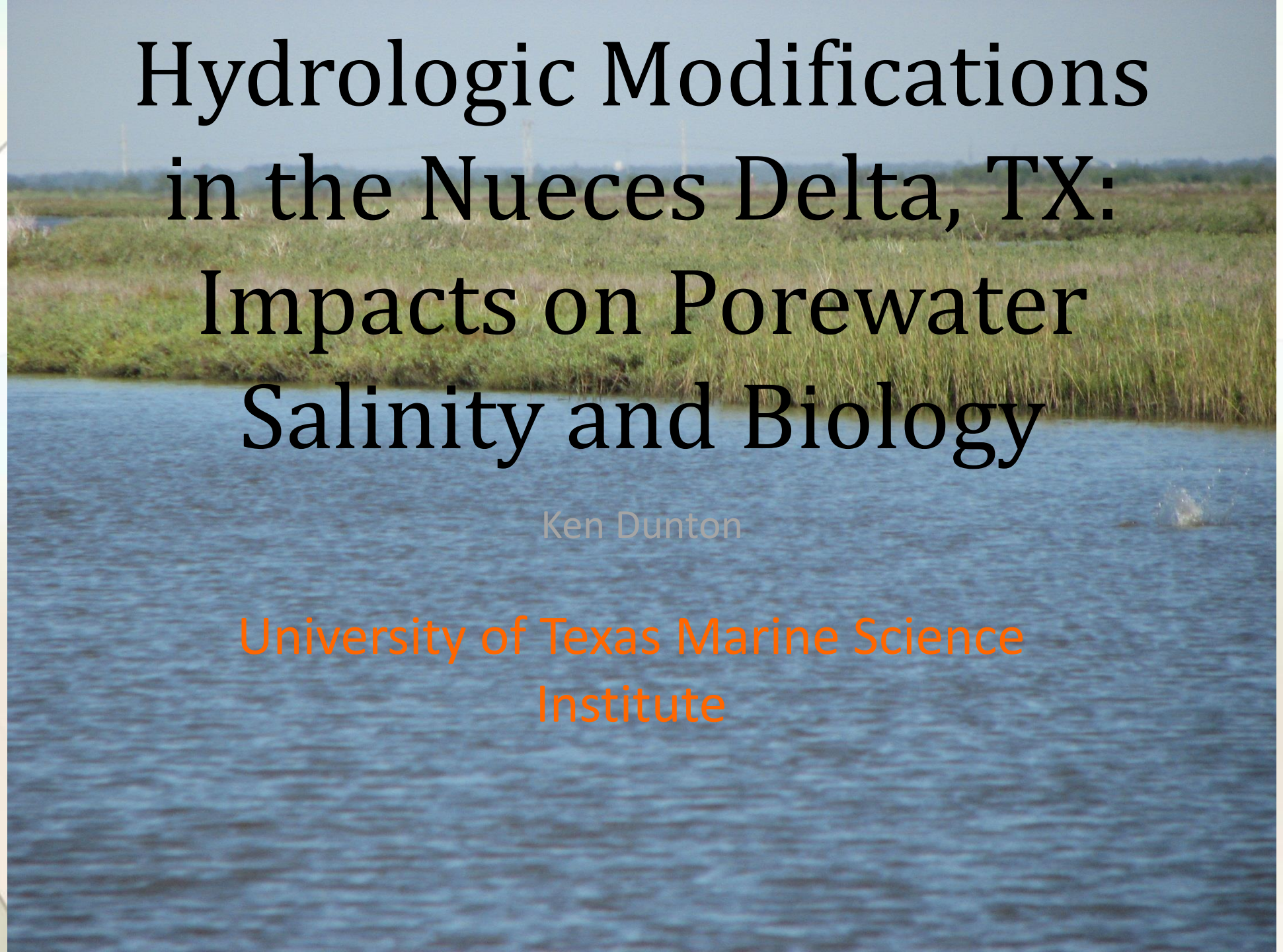
Projects Included in Final Modeling

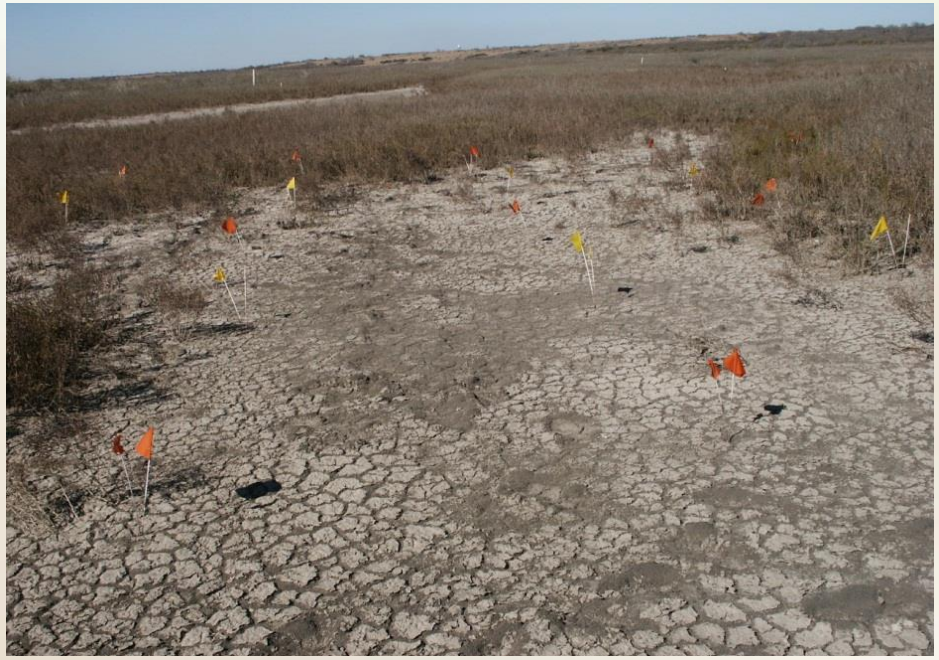
Hydrologic Modifications in the Nueces Delta, TX: Impacts on Porewater Salinity and Biology



Ken Dunton

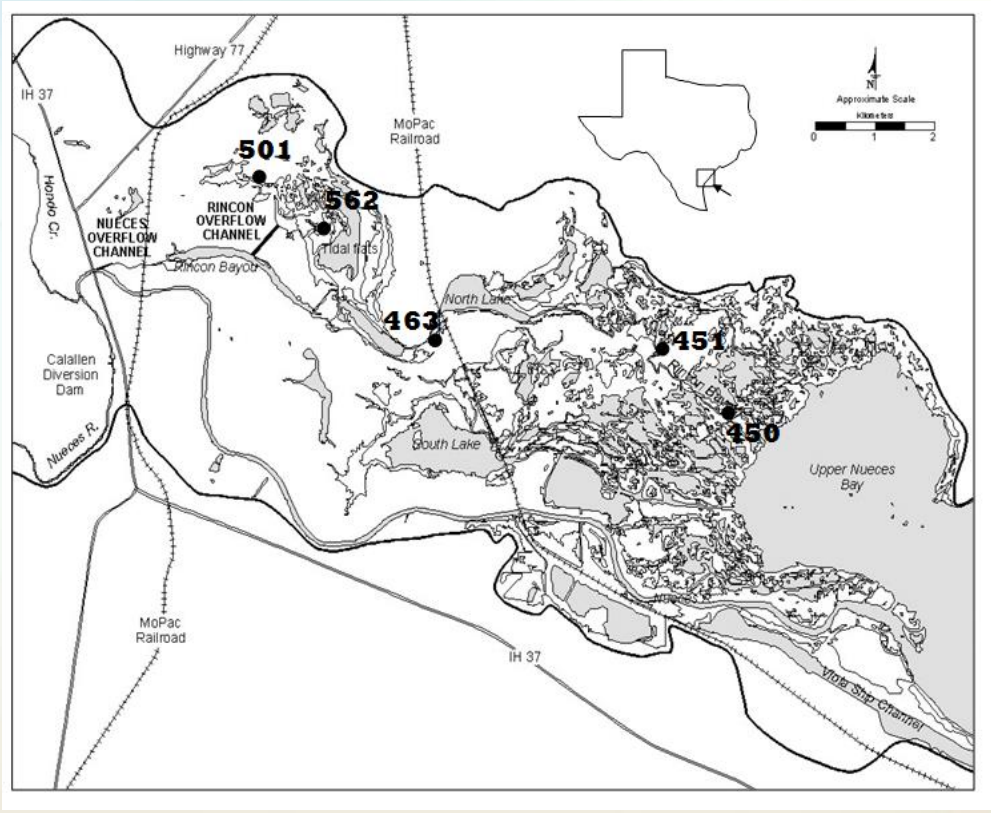
University of Texas Marine Science Institute

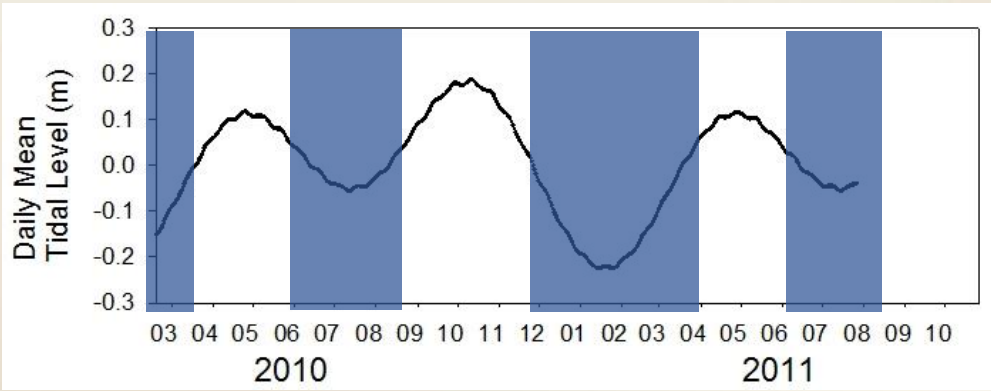
- What is the relationship between vegetation assemblages and salinity?



Physical Setting

- Microtidal (~15 cm amplitude)
- Conspicuous semiannual “tidal” harmonic
- Irregularly flooded



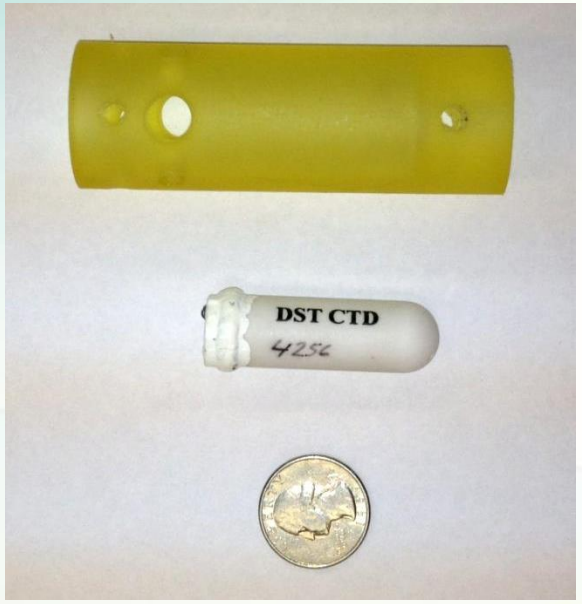


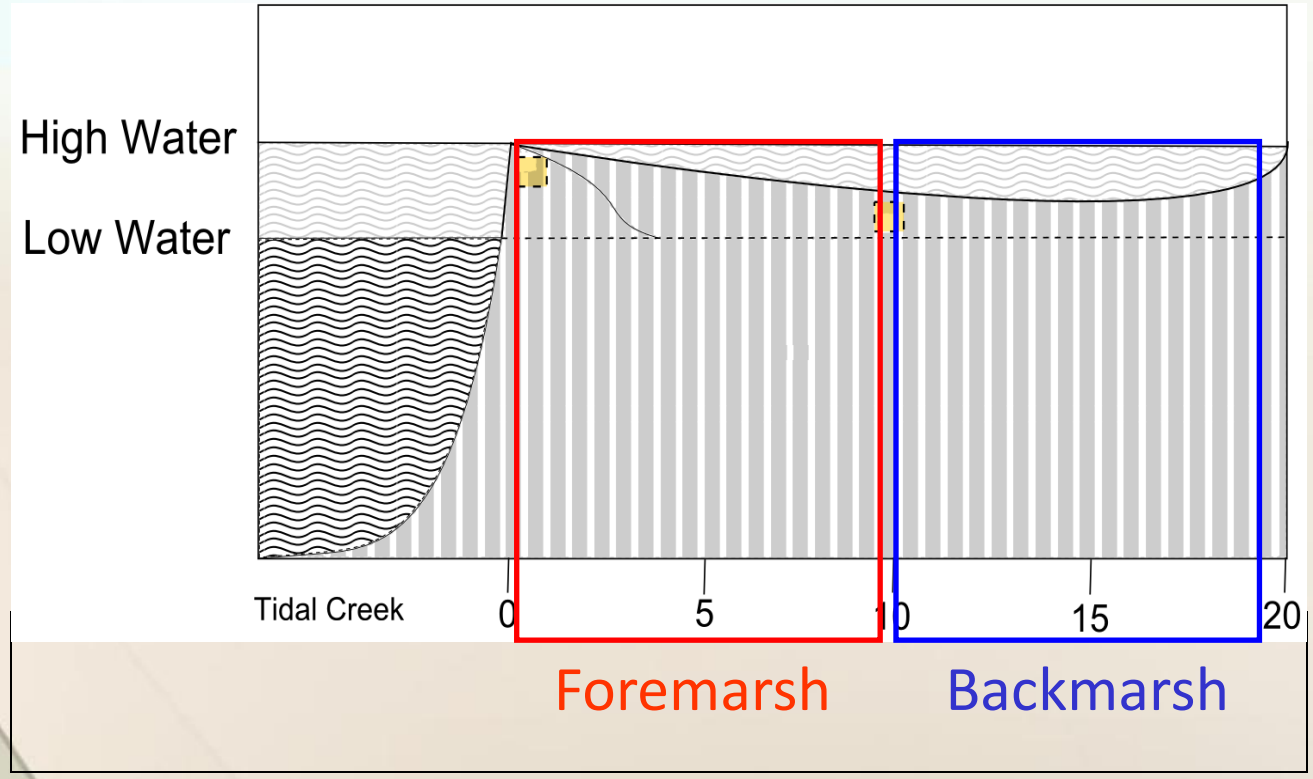
Physical Setting, cont'

Typical Winter Low Water Conditions versus Inundation during Fall High Water

Continuous Monitoring (2009- 2010)

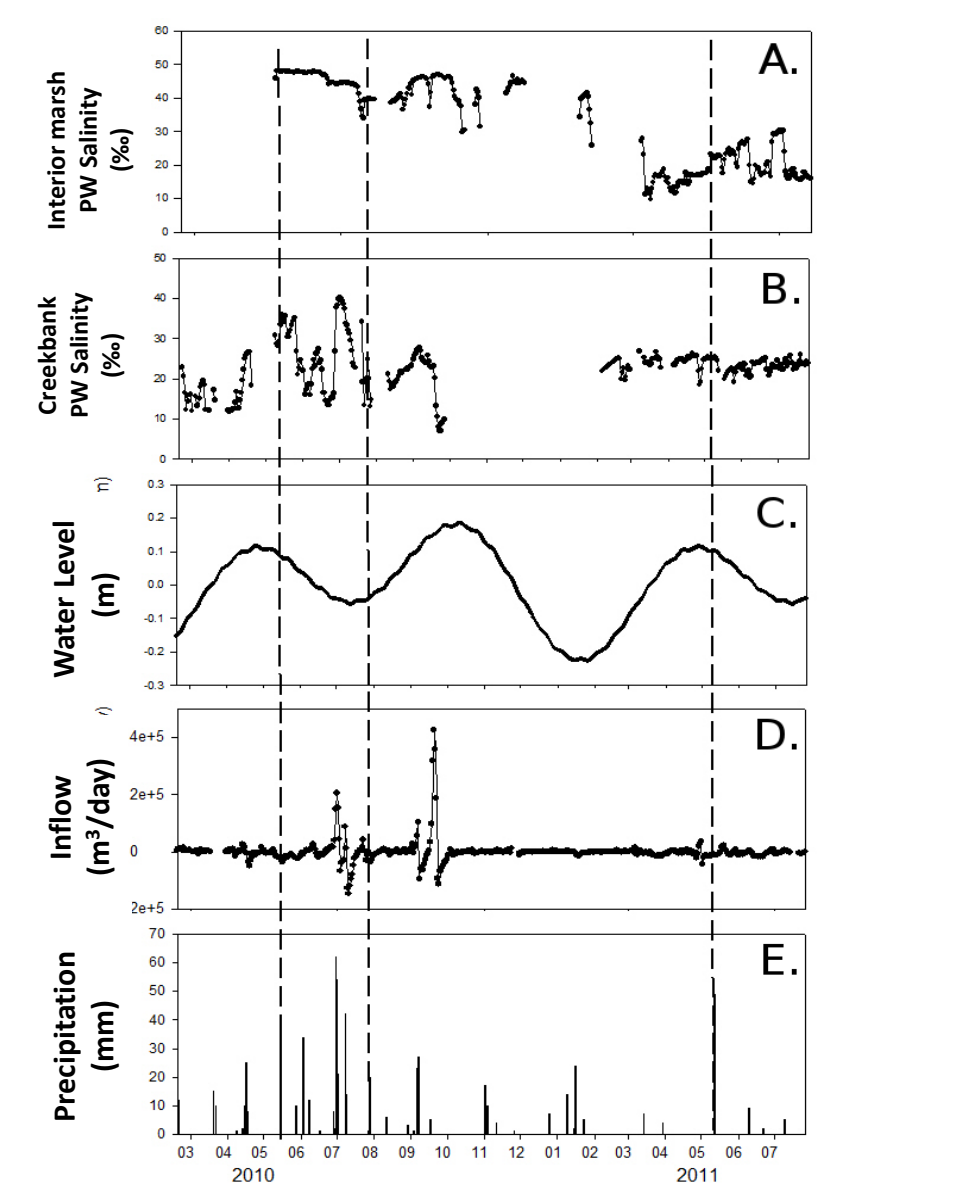
- 2 sites along the Rincon Bayou
- 2 salinity loggers per site





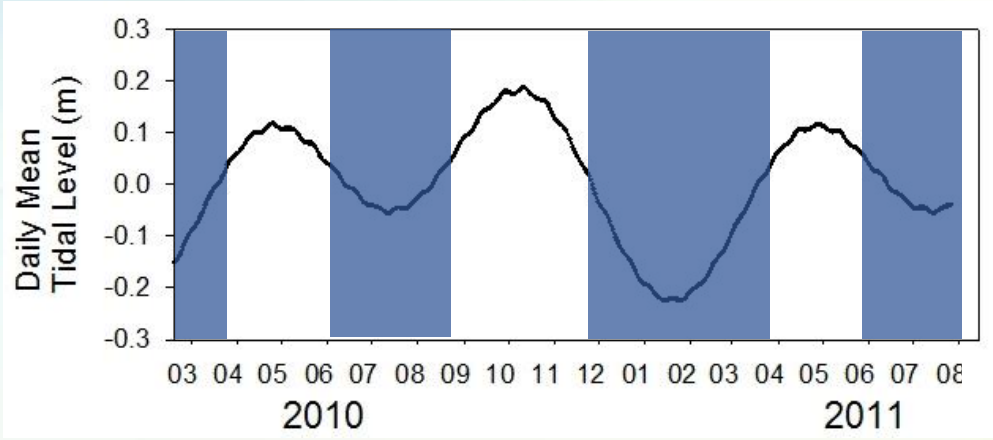
Time Series Data

- Creekbank salinities responded strongly to inflow events
- Average creekbank salinity = 23.8 ± 7.7
- Average interior marsh salinity = 44.2 ± 3.4
- Water levels vary seasonally

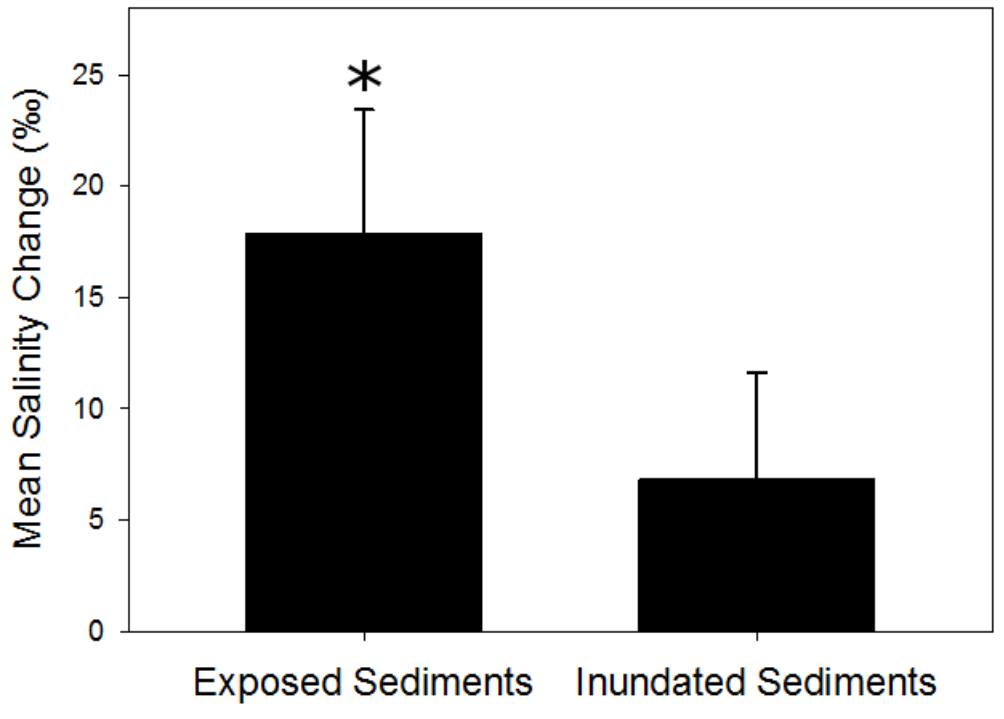


Precipitation Impacts

- Sediment exposure is strongly controlled by semiannual tides



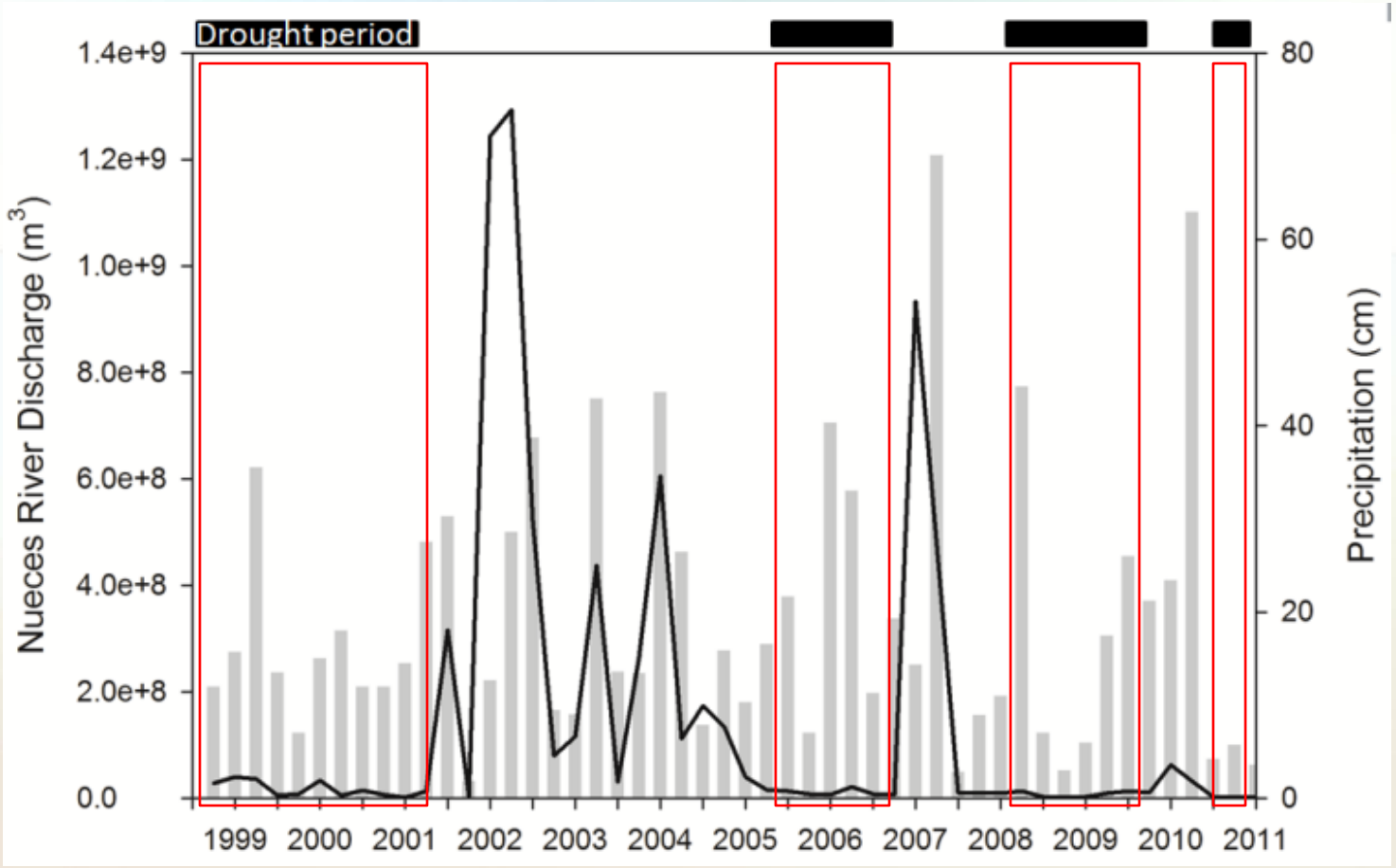
- Flushing of porewaters by precipitation limited to exposed sediments



Long Term Monitoring (1999-2011)

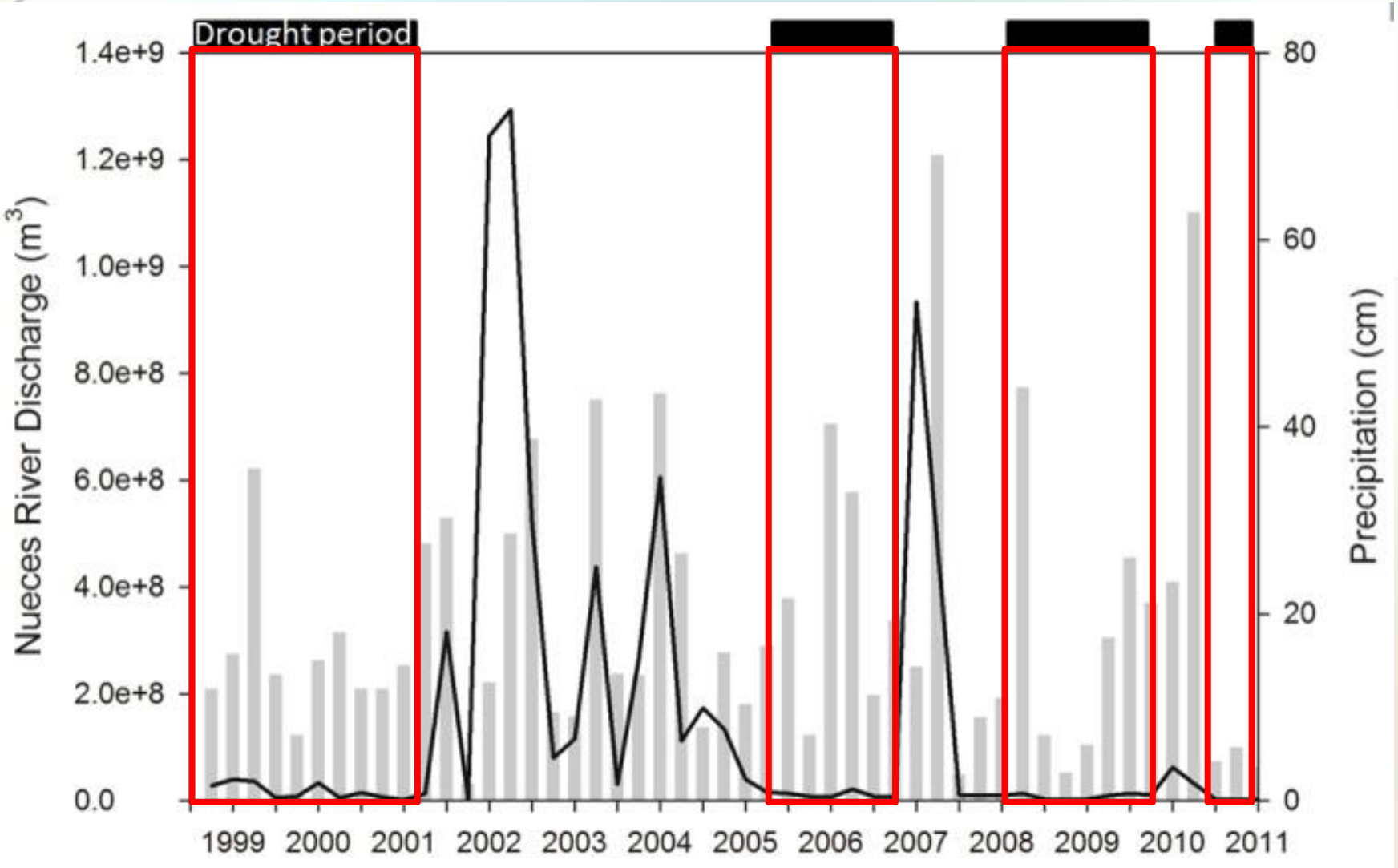
1. Plant abundance measured by quadrat on a percent cover basis
2. Porewater collection
3. Gauged freshwater inflows

Freshwater Inflow



- 3 wet periods: 2002-2004, 2007, 2010
- 3 dry periods: 1999-2001, 2005-06, 2008-09

Freshwater Inflow



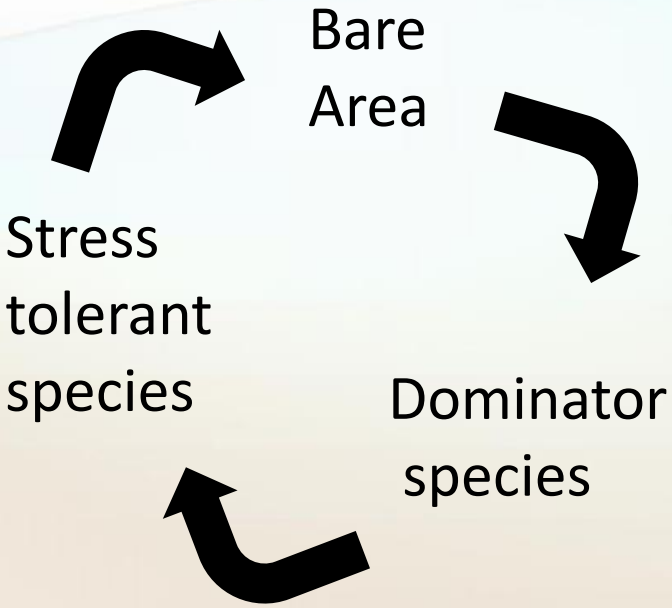
- 3 wet periods: 2002-2004, 2007, 2010
- 3 dry periods: 1999-2001, 2005-06, 2008-09

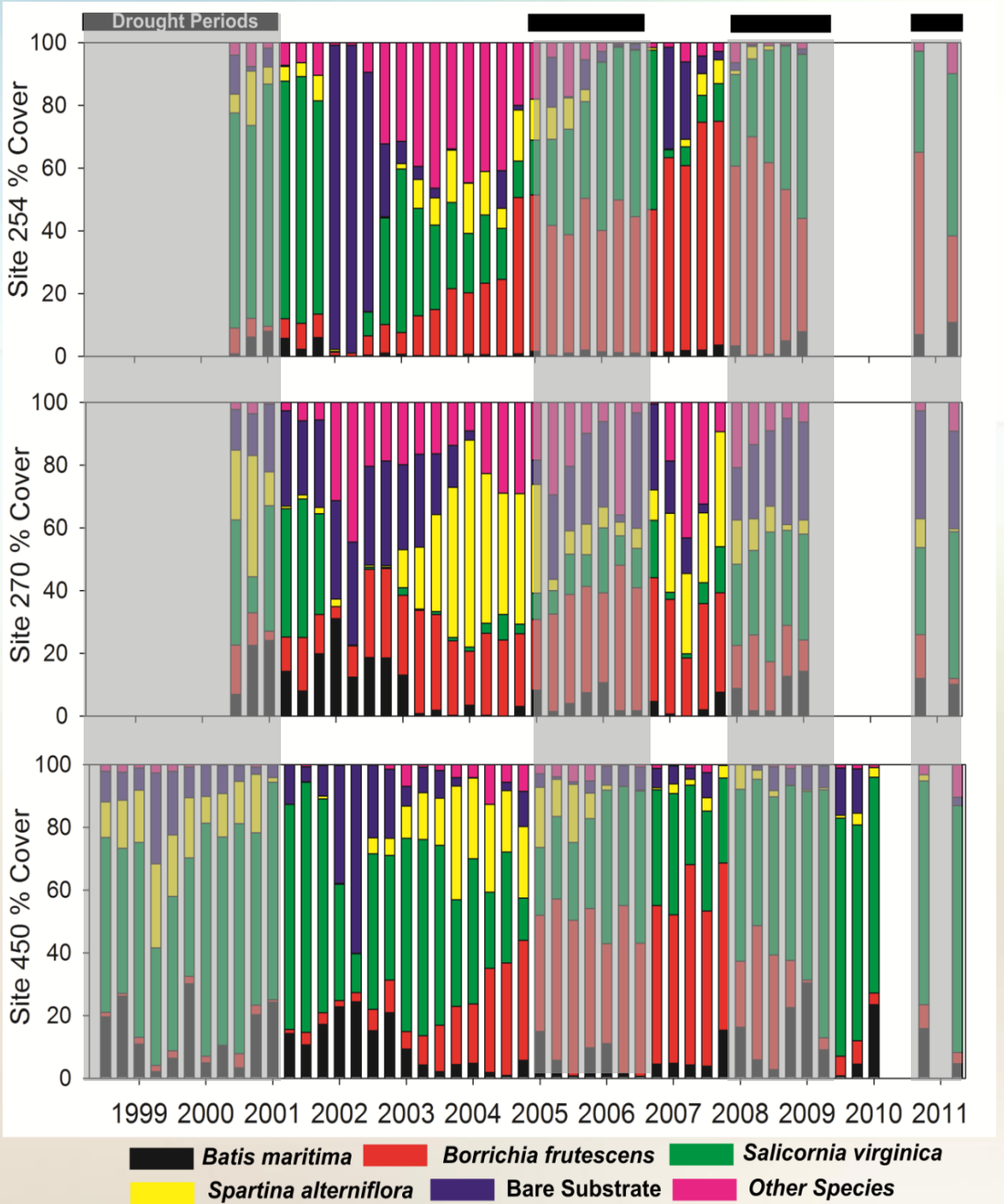
Environmental Controls (CCA)

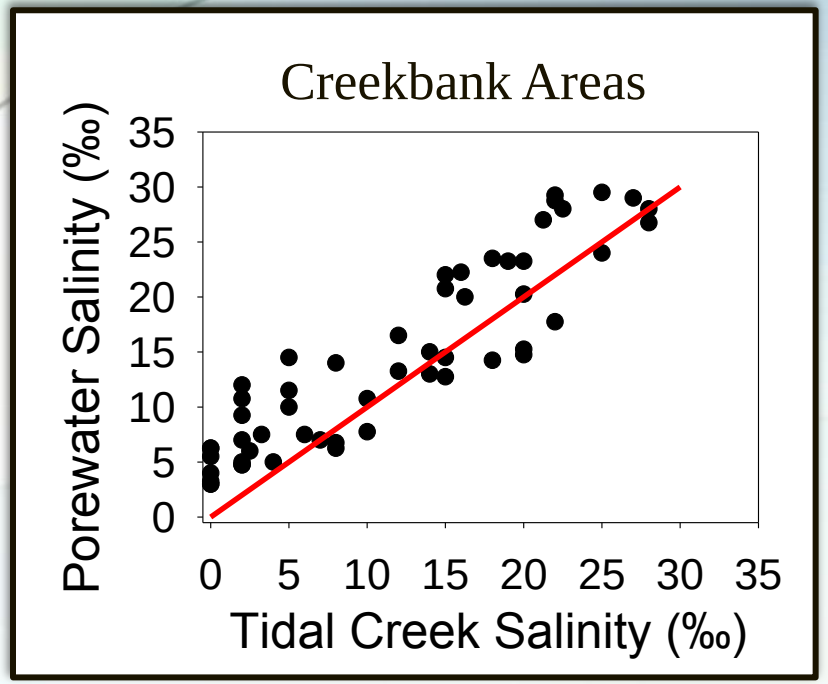
Scores for constraining variables	Axis 1	Axis 2
Porewater Salinity	**0.59**	-0.45
Porewater Ammonium	-0.01	0.34
Soil Moisture	**-0.94**	0.27
Distance to Tidal Creek	0.40	0.37
Distance to Nueces Bay	0.59	0.64
% Variance Explained	**77.93**	14.08

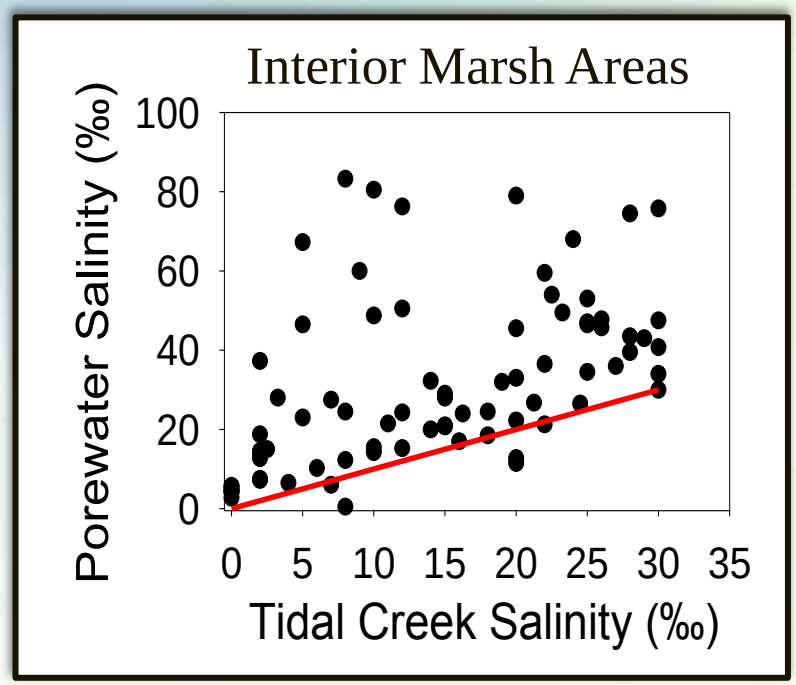
- Soil moisture and porewater salinity have large impacts on the overall vegetation assemblage
- The delta is characterized by an estuarine gradient

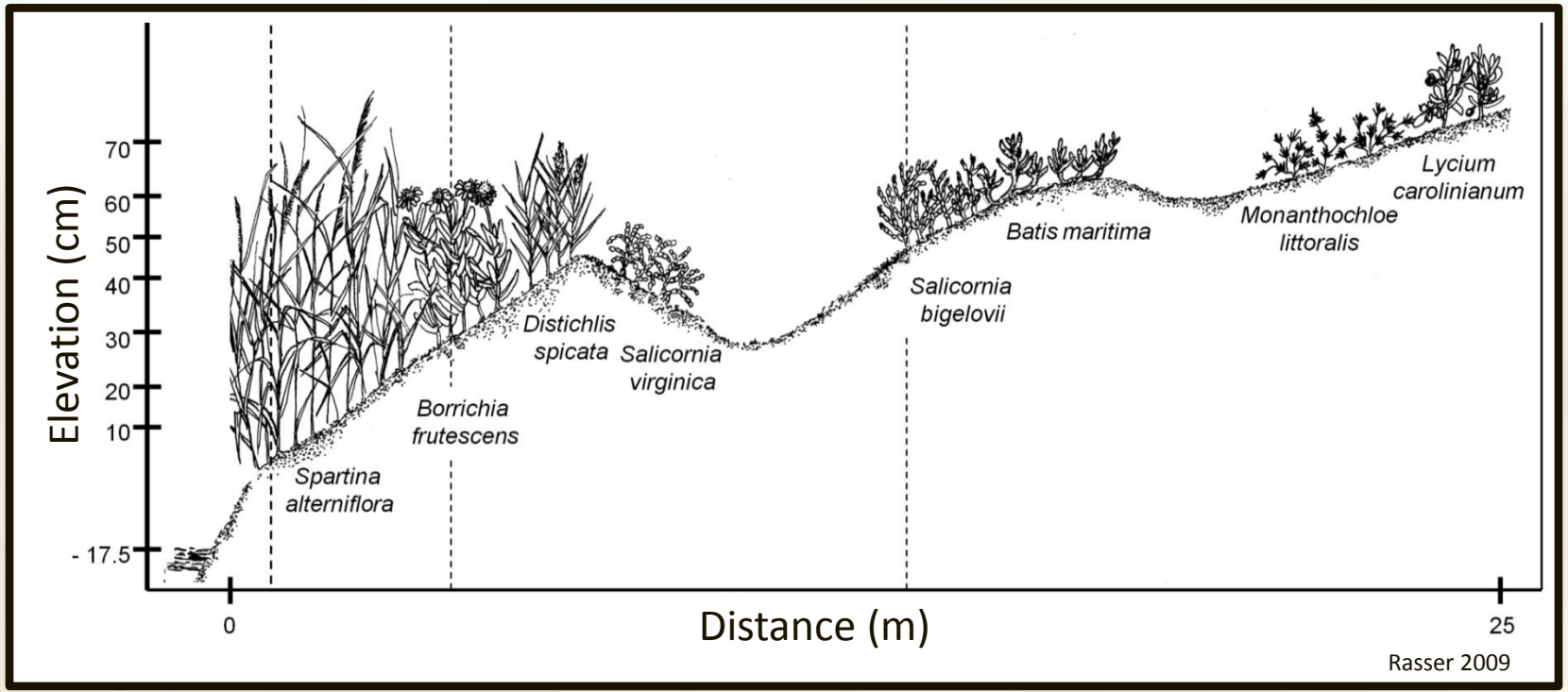
Vegetation Community





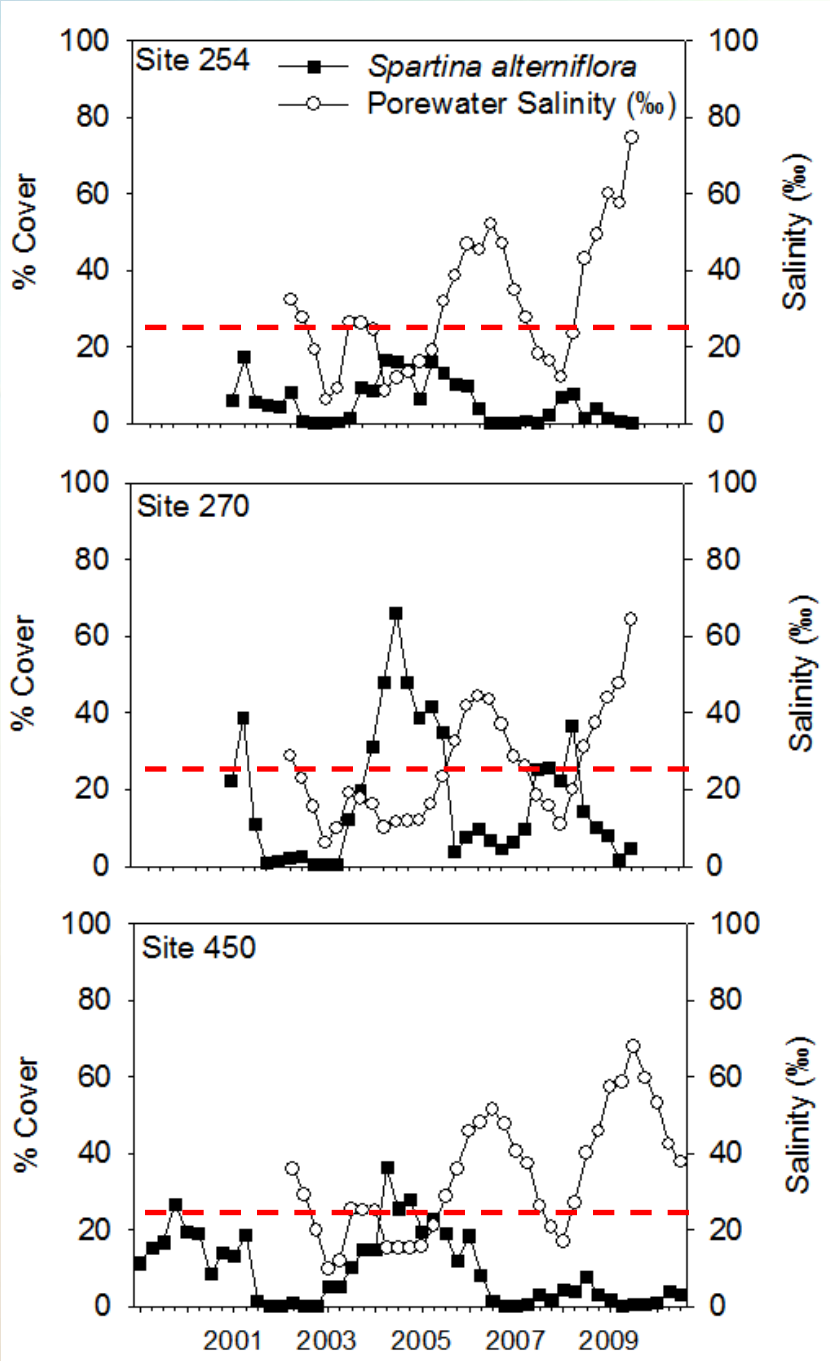

Creekbank Areas
Porewater Salinity (‰)
0
5
10
15
20
25
30
35
Tidal Creek Salinity (‰)


Interior Marsh Areas
Porewater Salinity (‰)
0
20
40
60
80
100
0 5 10 15 20 25 30 35
Tidal Creek Salinity (‰)

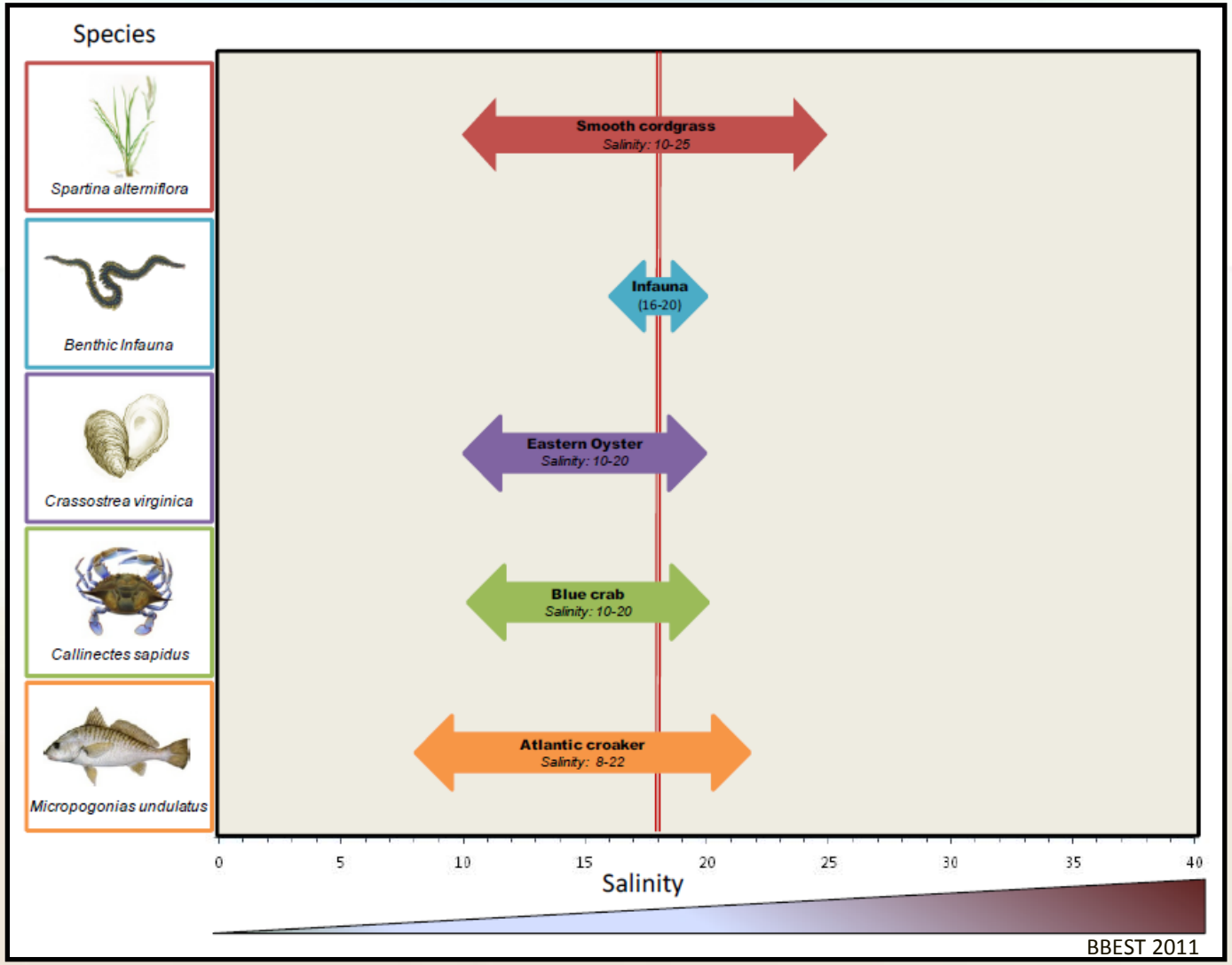

Elevation (cm)
70
60
50
40
30
20
10
- 17.5
Spartina alterniflora
Borrichia frutescens
Distichlis spicata
Salicornia virginica
Salicornia bigelovii
Batis maritima
Monanthochloe littoralis
Lycium carolinianum
0
Distance (m)
25
Rasser 2009

Salinity tolerance of *Spartina alterniflora*

- Porewater salinity exceeding 25 caused consistent decline in *Spartina* abundance



Salinity tolerance



- Salinity tolerance of *Spartina alterniflora* consistent with important faunal species

Conclusions

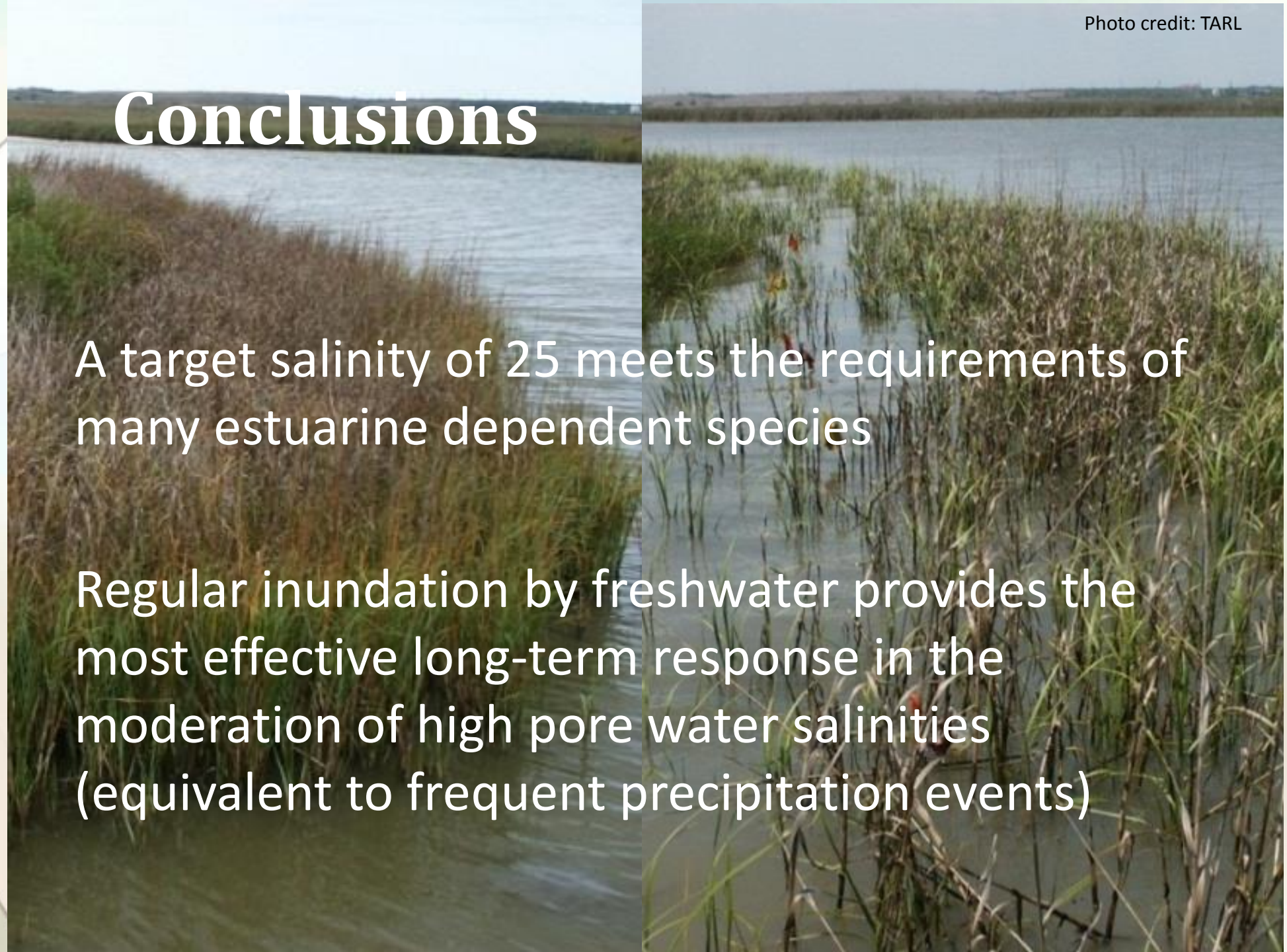


Photo credit: TARL

A target salinity of 25 meets the requirements of many estuarine dependent species

Regular inundation by freshwater provides the most effective long-term response in the moderation of high pore water salinities (equivalent to frequent precipitation events)

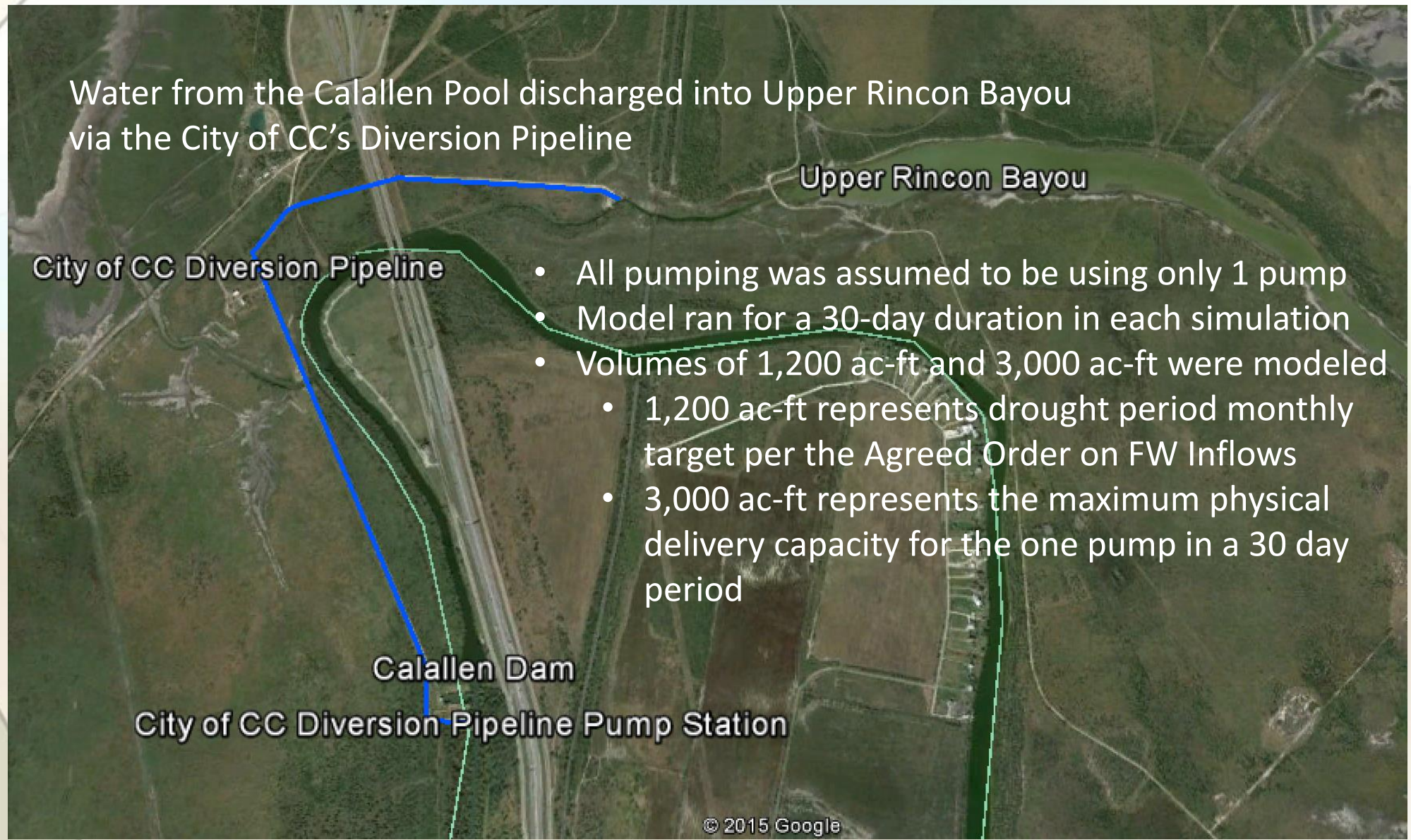
Project Alternative Modeling

Criteria established to compare alternatives:

- Provided a water column depth of ≧1 cm
- Provided an inundation duration of > 6.2 hours
- Provided a salinity of < 25 ppt, < 20 ppt, < 15 ppt

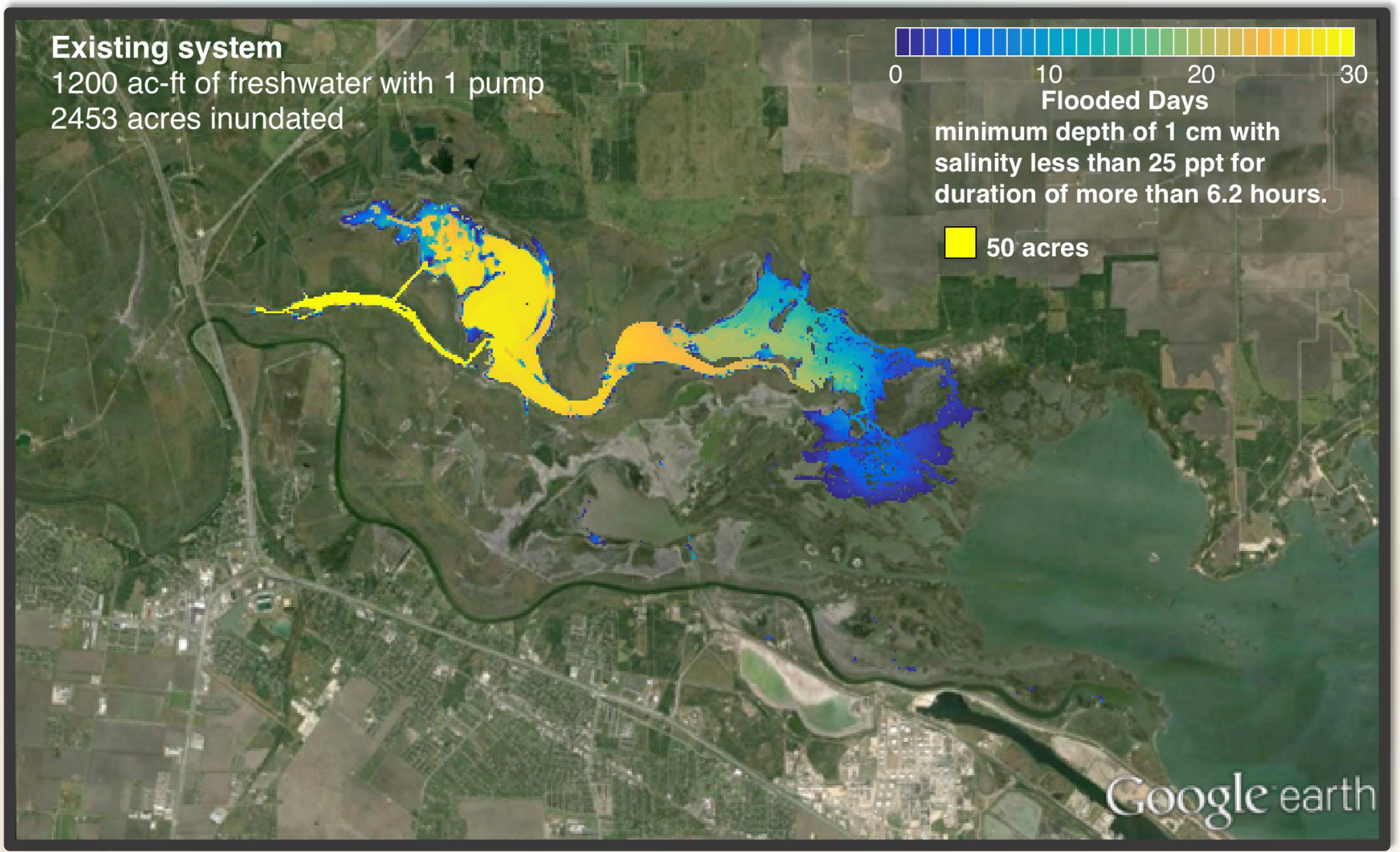
The depth and duration correspond to a typical tidal flooding period.

Modeling Parameters for Simulations

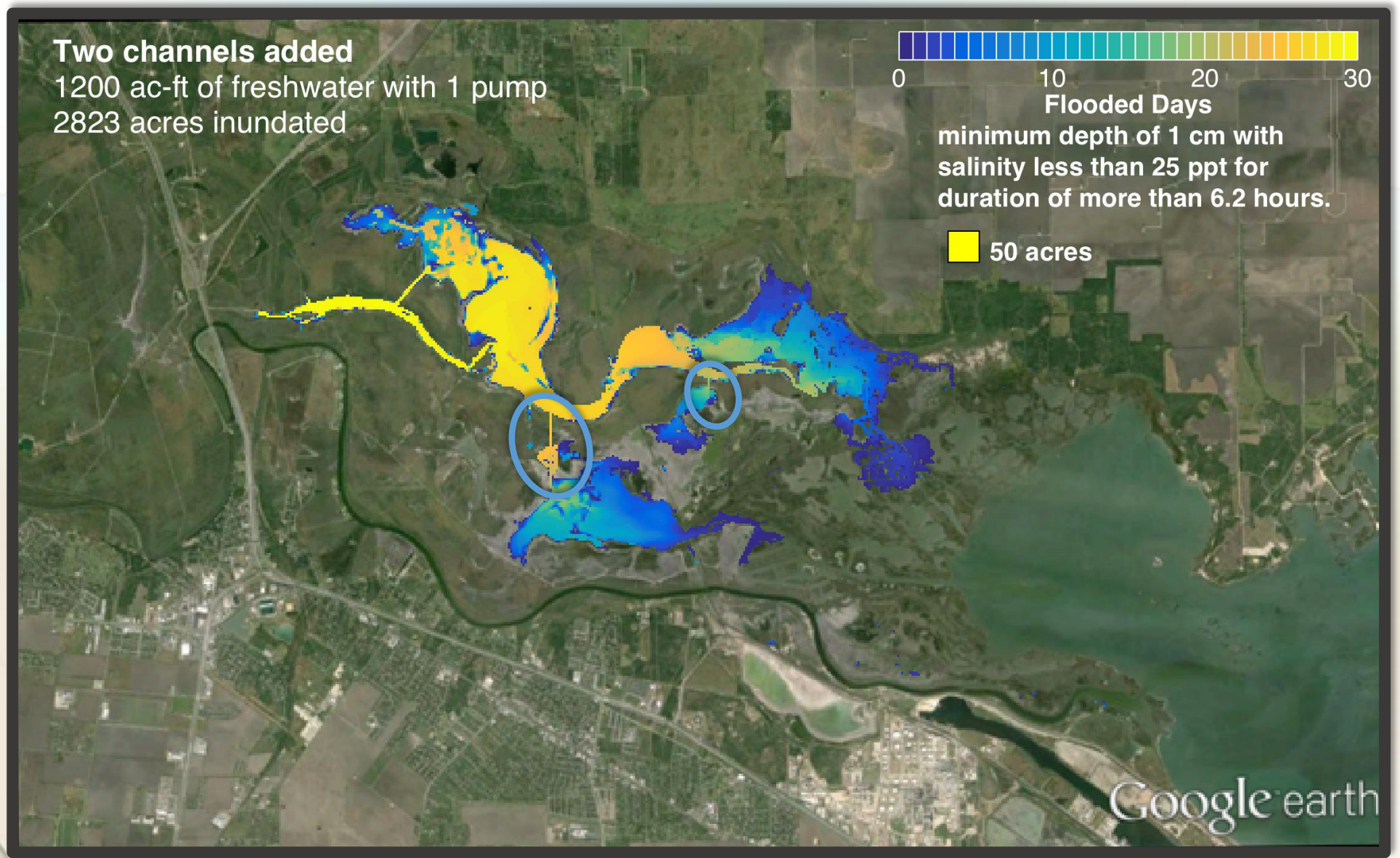


- All pumping was assumed to be using only 1 pump
- Model ran for a 30-day duration in each simulation
- Volumes of 1,200 ac-ft and 3,000 ac-ft were modeled
  - 1,200 ac-ft represents drought period monthly target per the Agreed Order on FW Inflows
  - 3,000 ac-ft represents the maximum physical delivery capacity for the one pump in a 30 day period

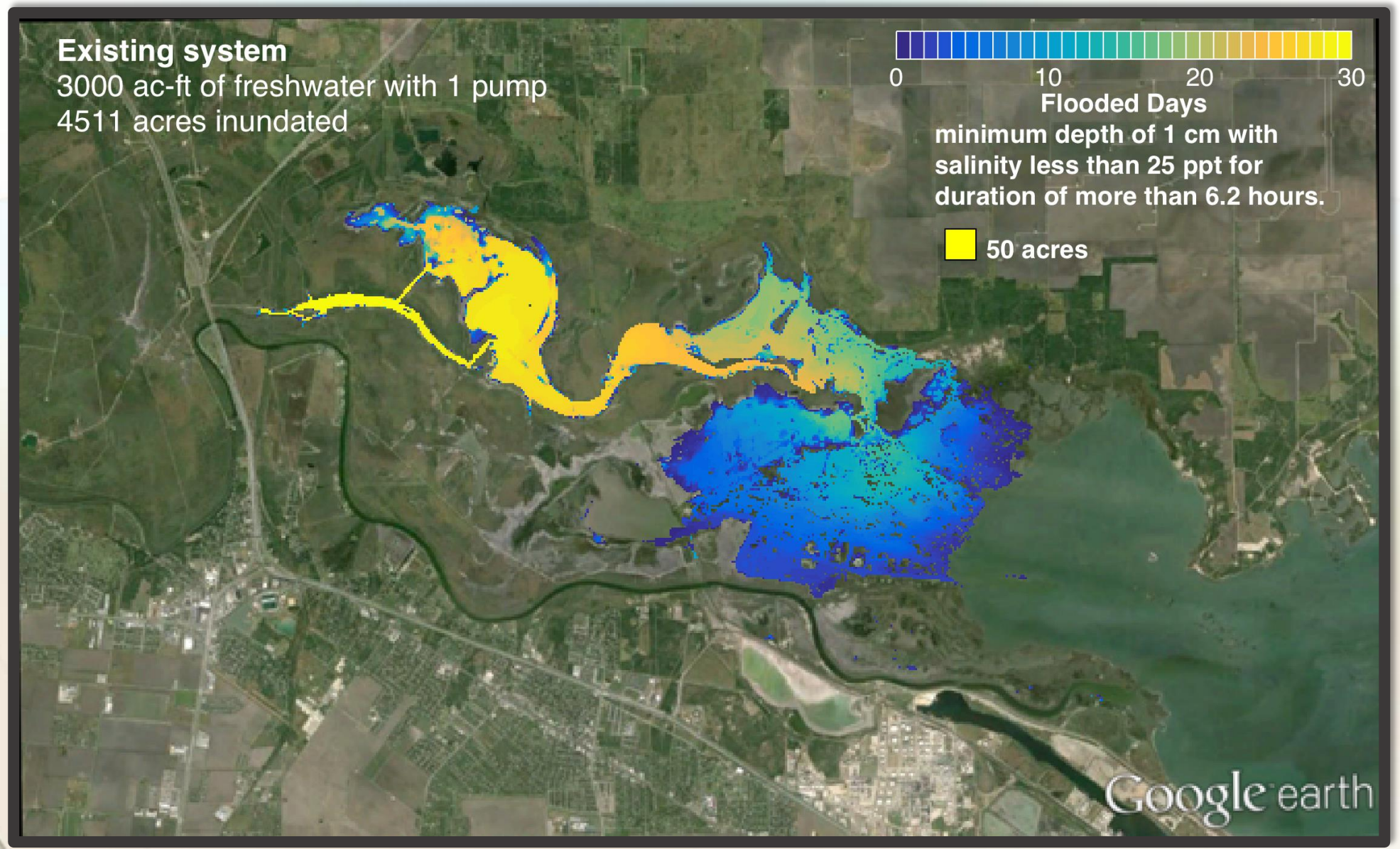
Existing System | 1,200 ac-ft | 2,453 acres inundated



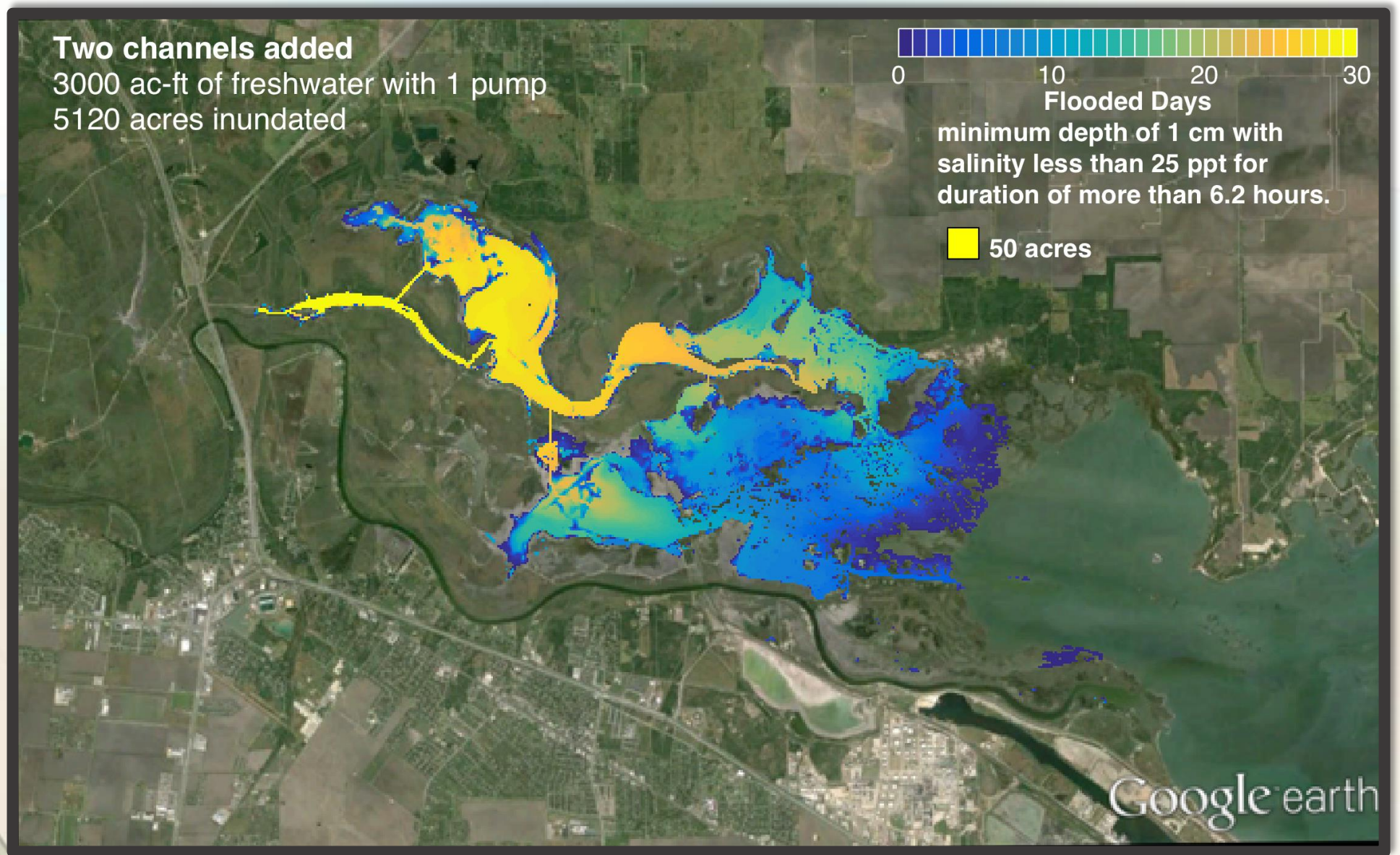
Modified System (Projects 4 & 5) | 1,200 ac-ft | 2,823 acres inundated



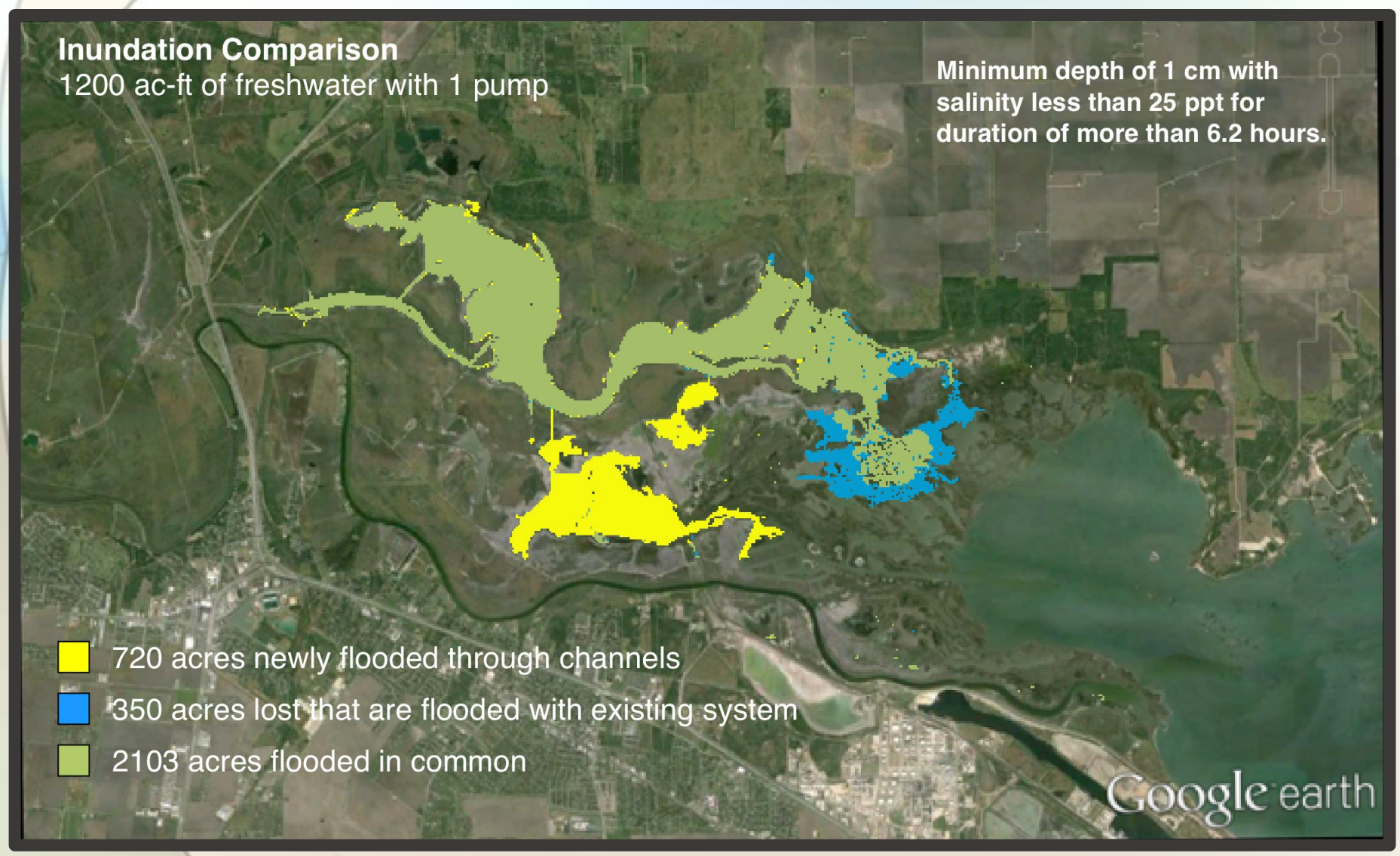
Existing System | 3,000 ac-ft | 4,511 acres inundated



Modified System (Projects 4 & 5) | 3,000 ac-ft | 5,120 acres inundated

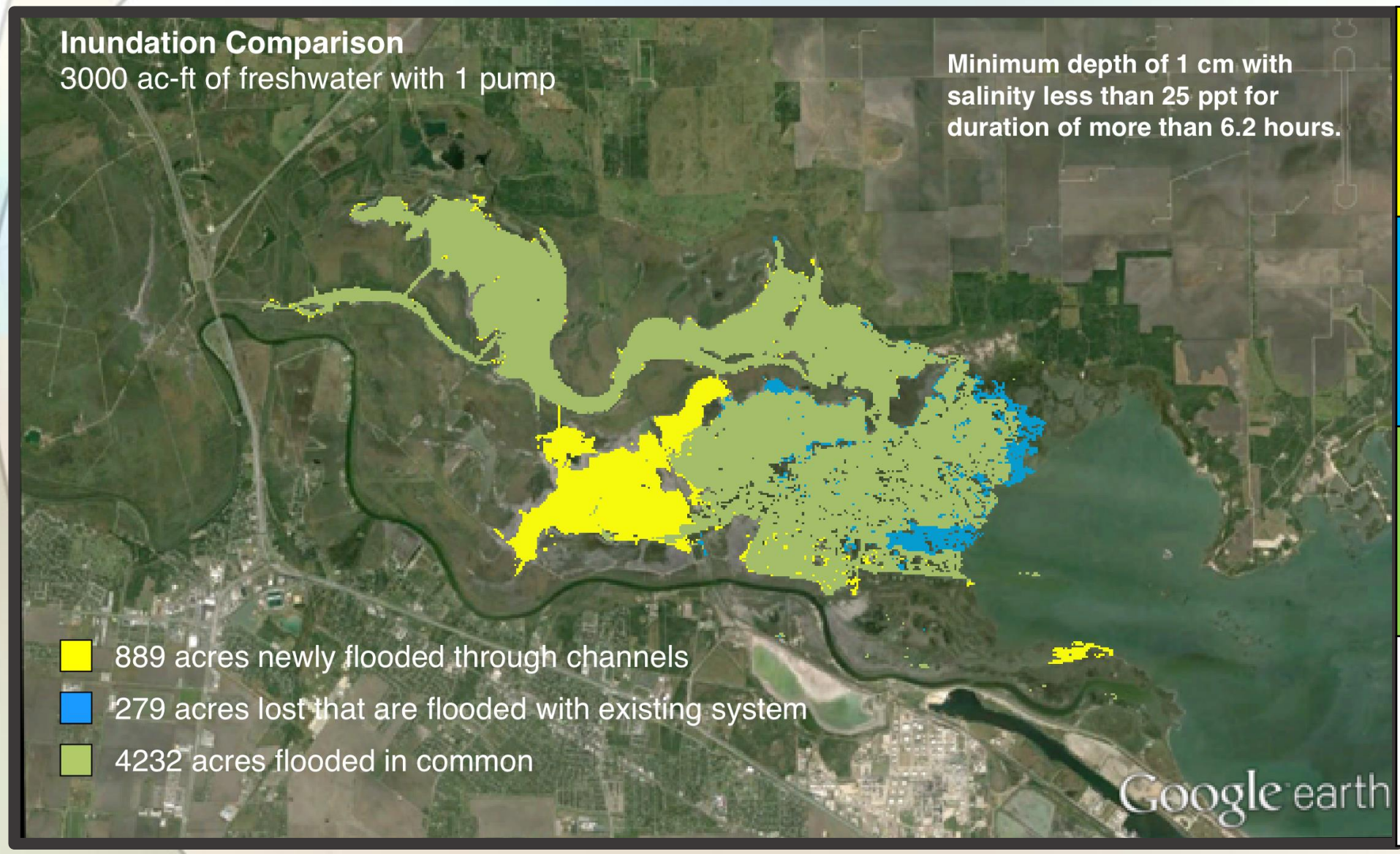


Modified System (Project 4 & 5) | 1,200 ac-ft | Salinity < 25 ppt



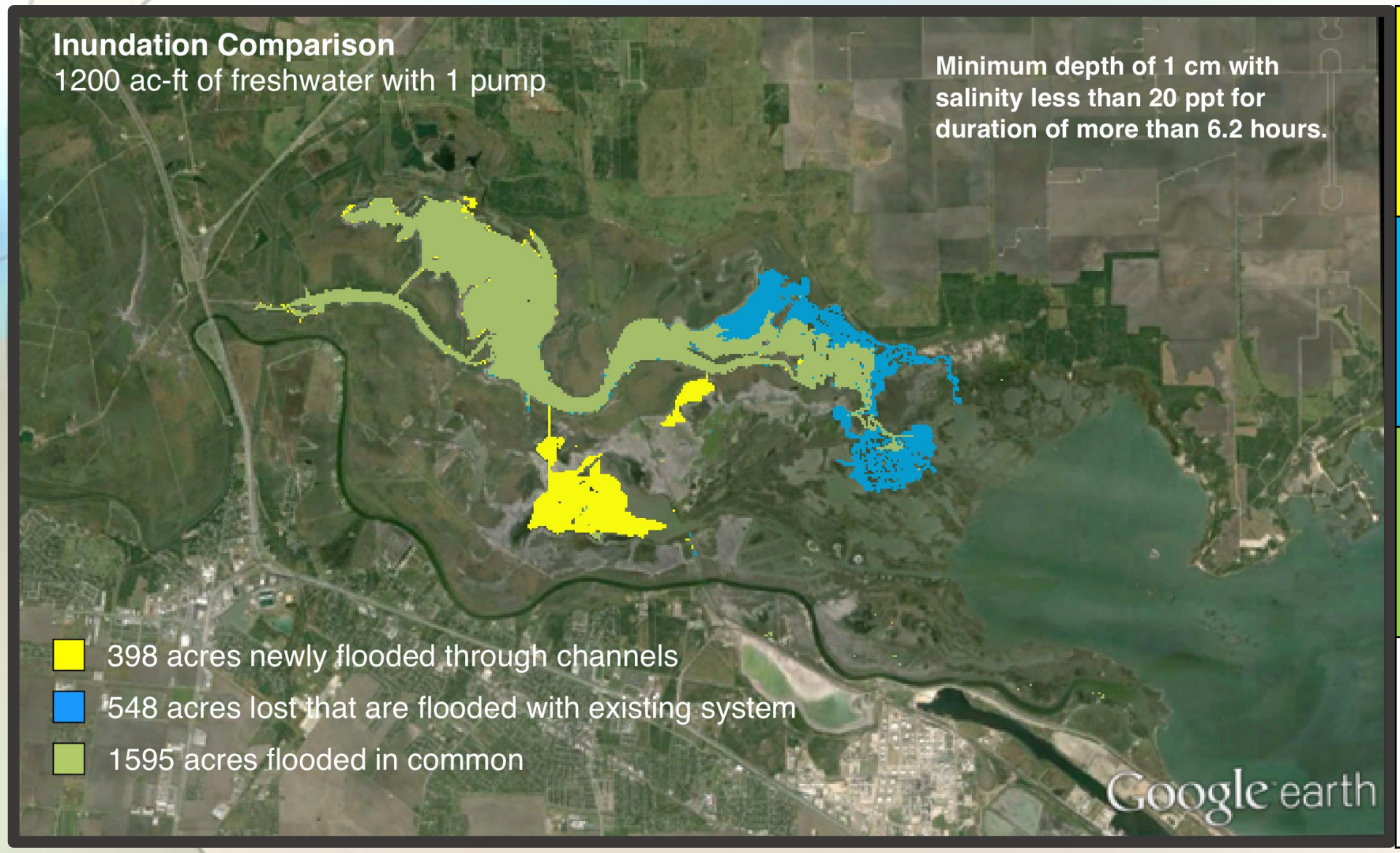
New acres:	720 ac
Lost acres:	350 ac
Acres in common with Existing System:	2,103 ac
Net Addition:	370 ac

Modified System (Project 4 & 5) | 3,000 ac-ft | salinity < 25 ppt



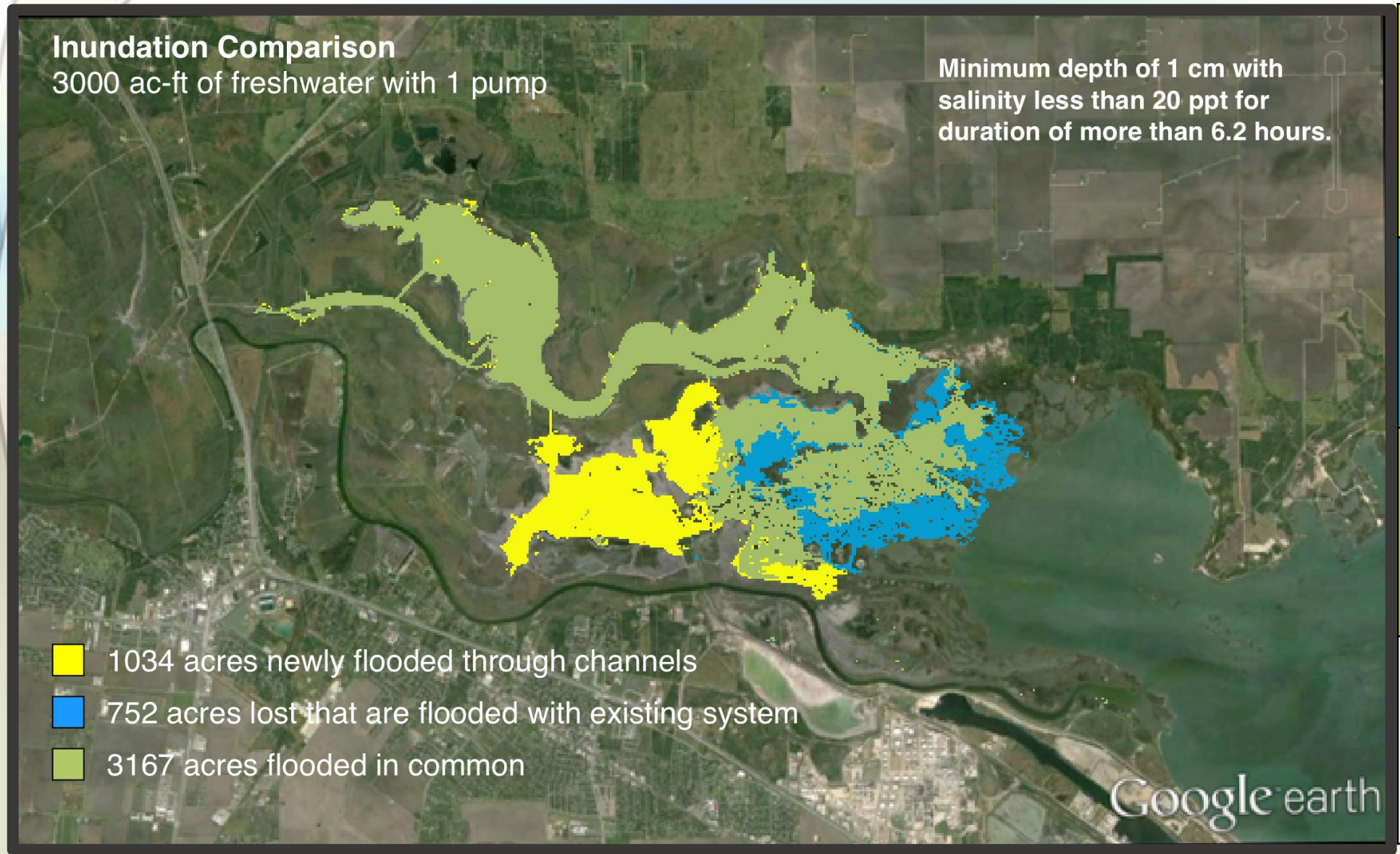
New acres:	889 ac
Lost acres:	279 ac
Acres in common with Existing System:	4,323 ac
Net Addition:	610 ac

Modified System (Project 4 & 5) | 1,200 ac-ft | salinity < 20 ppt



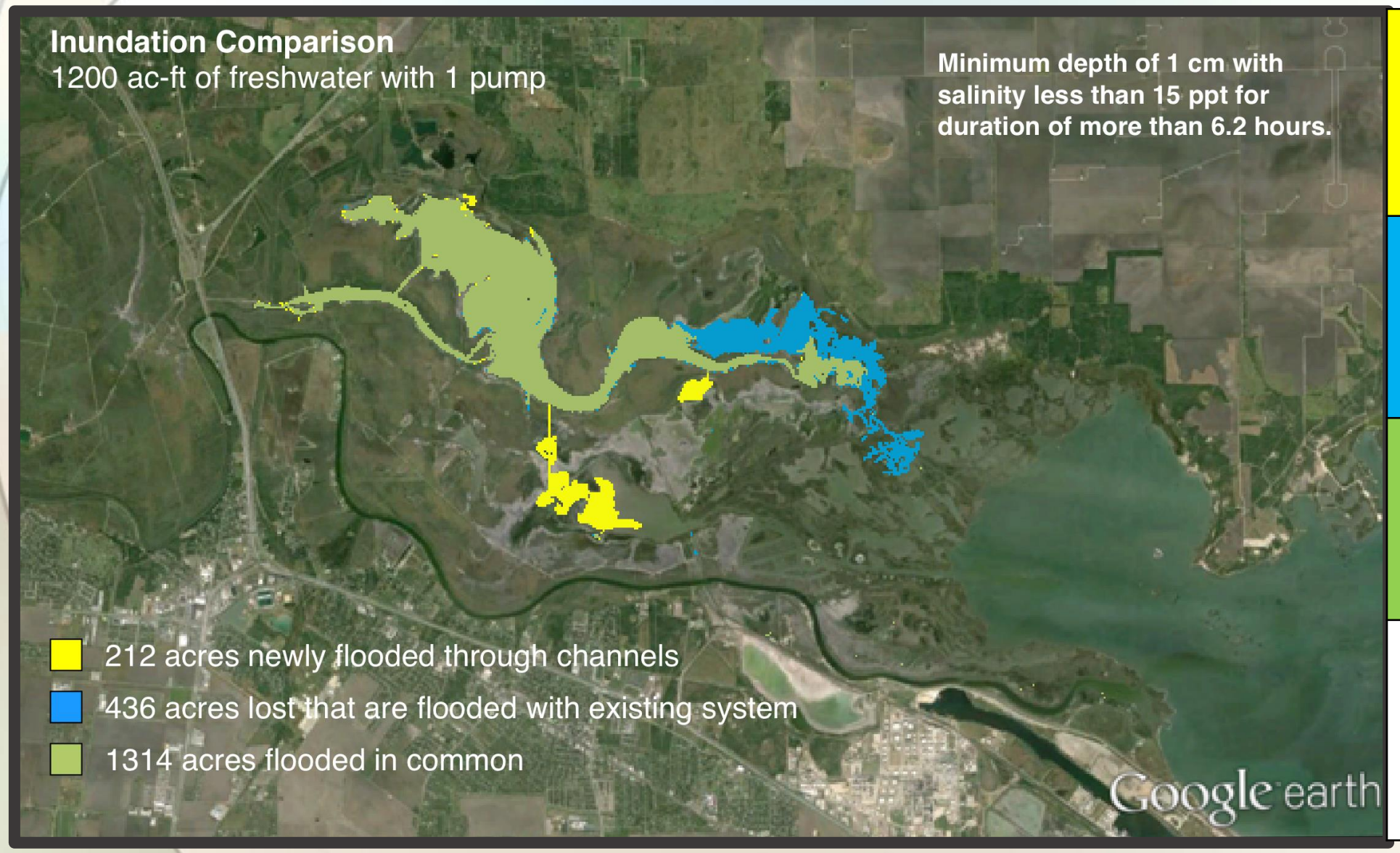
New acres:	398 ac
Lost acres:	548 ac
Acres in common with Existing System:	1,595 ac
Net Addition:	-150 ac

Modified System (Project 4 & 5) | 3,000 ac-ft | salinity < 20 ppt



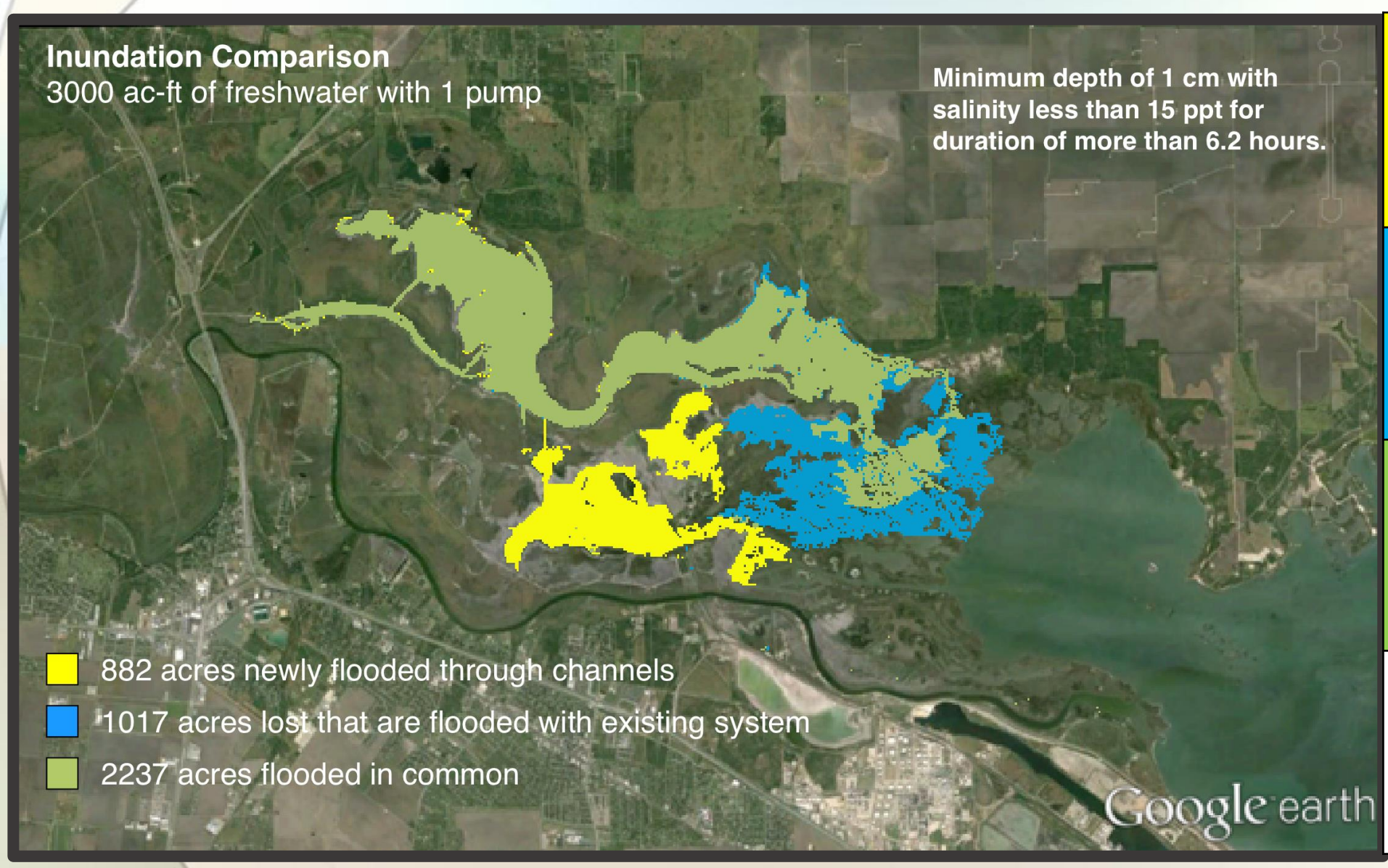
New acres:	1,034 ac
Lost acres:	752 ac
Acres in common with Existing System:	3,167 ac
Net Addition:	282 ac

Modified System (Project 4 & 5) | 1,200 ac-ft | salinity < 15 ppt



New acres:	212 ac
Lost acres:	436 ac
Acres in common with Existing System:	1,314 ac
Net Addition:	-224 ac

Modified System (Project 4 & 5) | 3,000 ac-ft | salinity < 15 ppt



New acres:	882 ac
Lost acres:	1,017 ac
Acres in common with Existing System:	2,237 ac
Net Addition:	-135 ac

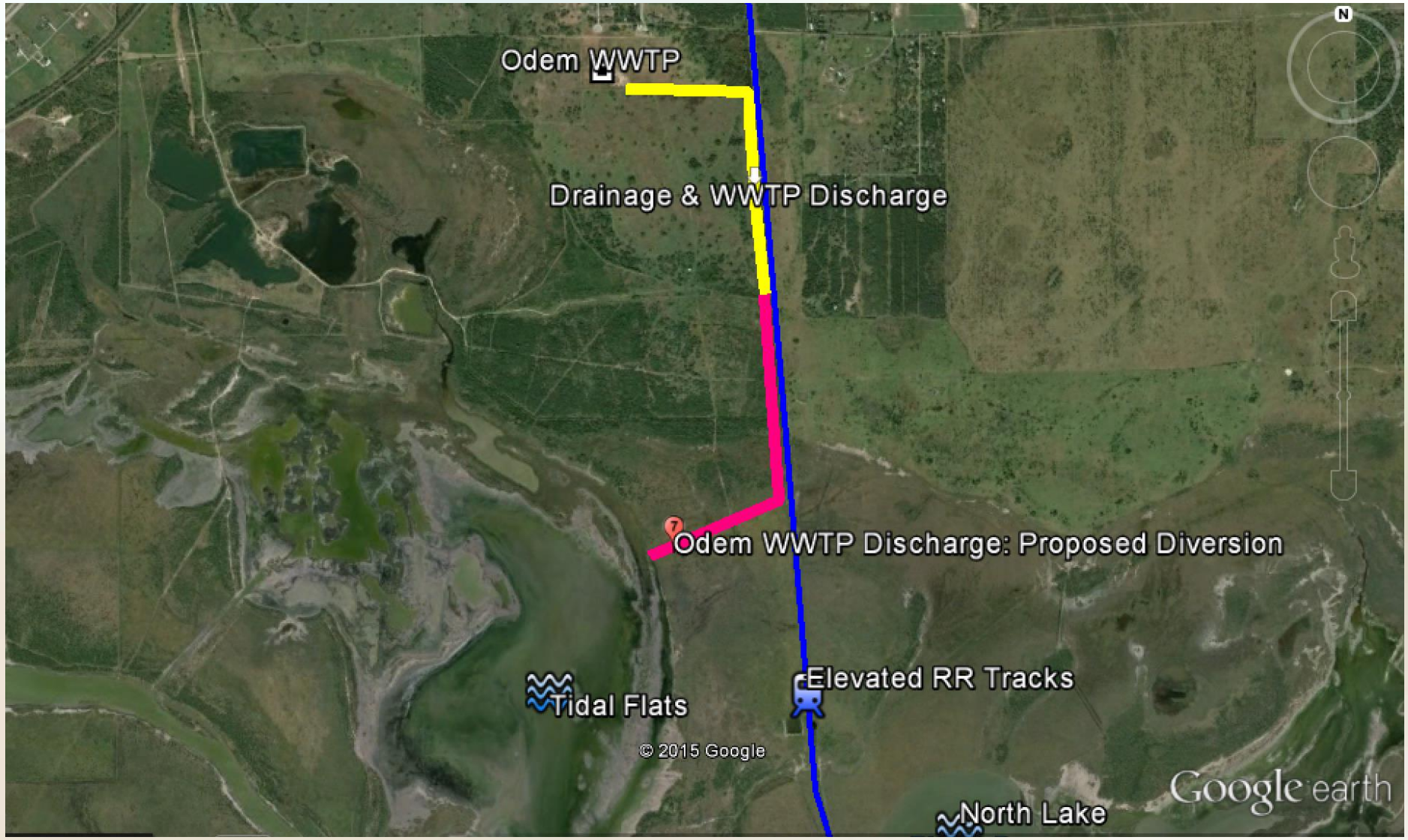
Modified System (Project 4 & 5)
Summary of Results for
Varying Salinity Criteria and Volumes Pumped

Salinity Criteria:	< 25 ppt		< 20 ppt		< 15 ppt	
Ac-ft pumped:	1,200	3,000	1,200	3,000	1,200	3,000
New Acres:	720	889	398	1,034	212	882
Lost Acres:	350	279	548	752	436	1,017
Acres in Common w/ Existing System:	2,103	4,323	1,595	3,167	1,314	2,237
Net Addition:	370	610	-150	282	-224	-135

The overall picture is that the simple inclusion of the channels is effective in increasing the area flooded with 20-25 ppt salinity, but at the expense of reducing some of the areas that would otherwise see salinities below 15 ppt.

Odem WWTP Discharge Diversion

Modeled impacts of the Q of Odem WTTP discharge, over the 30-day modeling period are negligible, but long-term benefits of moving more freshwater into tidal flats area, as measured on an annual basis, is probable



Conclusions

- Evaluation of several potential landform and hydraulic modifications in the Nueces Delta/Upper Nueces Bay revealed that two new channels diverting water from Rincon Bayou would inundate and lower salinities in areas to the south of the main channel, as compared to existing conditions, although, in some cases, at the expense of some areas which were inundated before the new channels were included in the model.
- The recently developed hydraulic model of the Nueces Delta proved to be extremely useful in the preliminary evaluation of project alternatives and the quantification of impacts associated with selected configurations of hydraulic modifications.
- Further modeling should be undertaken to design and evaluate a “system operations” concept for the pumping of required Pass-Thru flows into Rincon Bayou and the operation of water control structures which would be associated with the two proposed diversion channels.